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CIVIL ENGINEERING MATERIALS

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PREFACE

The purpose of writing this eBook is to provide the students with a understanding of the concrete materials and mixture. Relevant exercises are provided at the end of the chapter to help students to understanding the topics.

This eBook is suitable for students knowledge and study in the construction field. The content of this eBook is also useful for students to understand the application of concrete in construction and any related industry.

Any suggestions, comments and feedback for further improvement are most welcome.

Isma Afiza Binti Ismail
Marliza Ashiqin Binti Khazali
Maswira Binti Mahasan

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CHAPTER 1.0
CONCRETE MATERIALS & MIXTURE

ISMA AFIZA BINTI ISMAIL
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CONCRETE

MATERIALS & MIXTURE

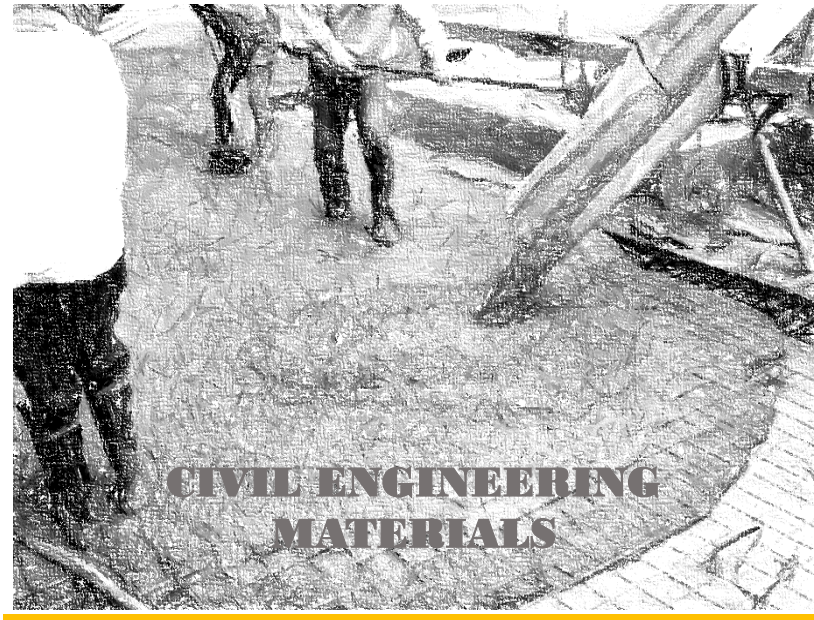
Definition:

Concrete is a composite construction material composed of cement and other cementations materials such as fly ash and slag cement, aggregate (generally a coarse aggregate made of gravels or crushed rocks such as limestone or granite, plus a fine aggregate such as sand), water and chemical admixtures.

''Encyclopedia"

CHAPTER 1.0

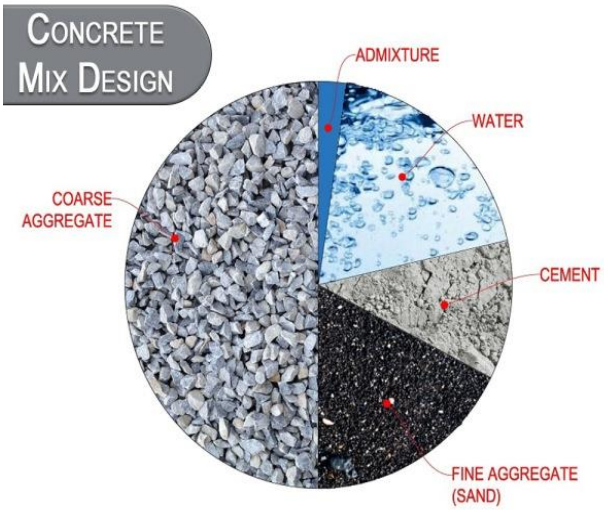
DIFFERENT COMPONENTS OF CONCRETE MATERIALS.



DEFINITION OF CONCRETE.

CONCRETE

Concrete is a widely used construction material which is a mixture of cement, aggregates, water and admixture



TYPES OF CONCRETE USED IN THE INDUSTRY

The requirement of concrete properties is varying depending on the types of structural elements, geometrical features of the structure, time of concrete placement and number of skill labourers.

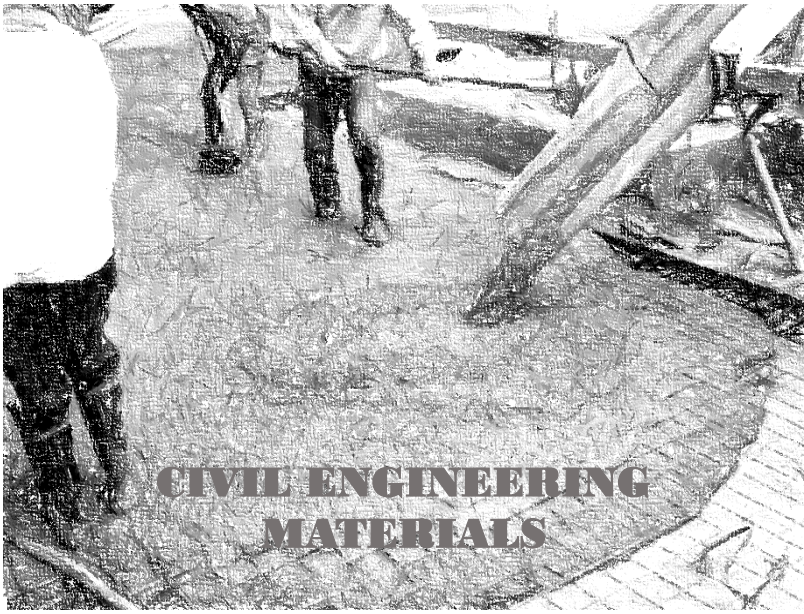
- **Normal concrete**
- **High strength concrete**
- **High performance concrete**
- **Self compacting concrete**
- **Pervious concrete**
- **Light weight concrete**
- **Aqua concrete**

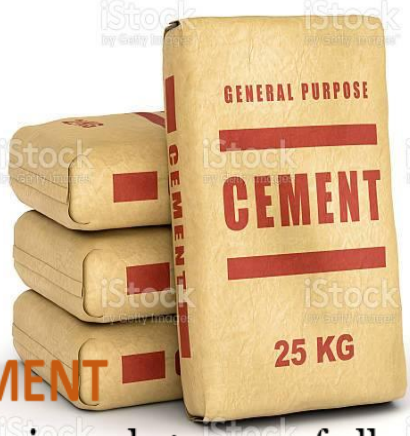
GRADE OF CONCRETE

The frequently used grade of concrete is M20 to M40 for R.C.C.
The minimum grade of concrete prescribed by IS456:2000 is M20 for R.C.C & for P.C.C is M10.

CHAPTER 1.0

CEMENT, FINE AGGREGATE, COARSE AGGREGATE AND WATER.





CEMENT

adhesive substances of all kinds, but, in a narrower sense, the binding materials used in building and civil engineering construction.

FINE AND COARSE AGGREGATES

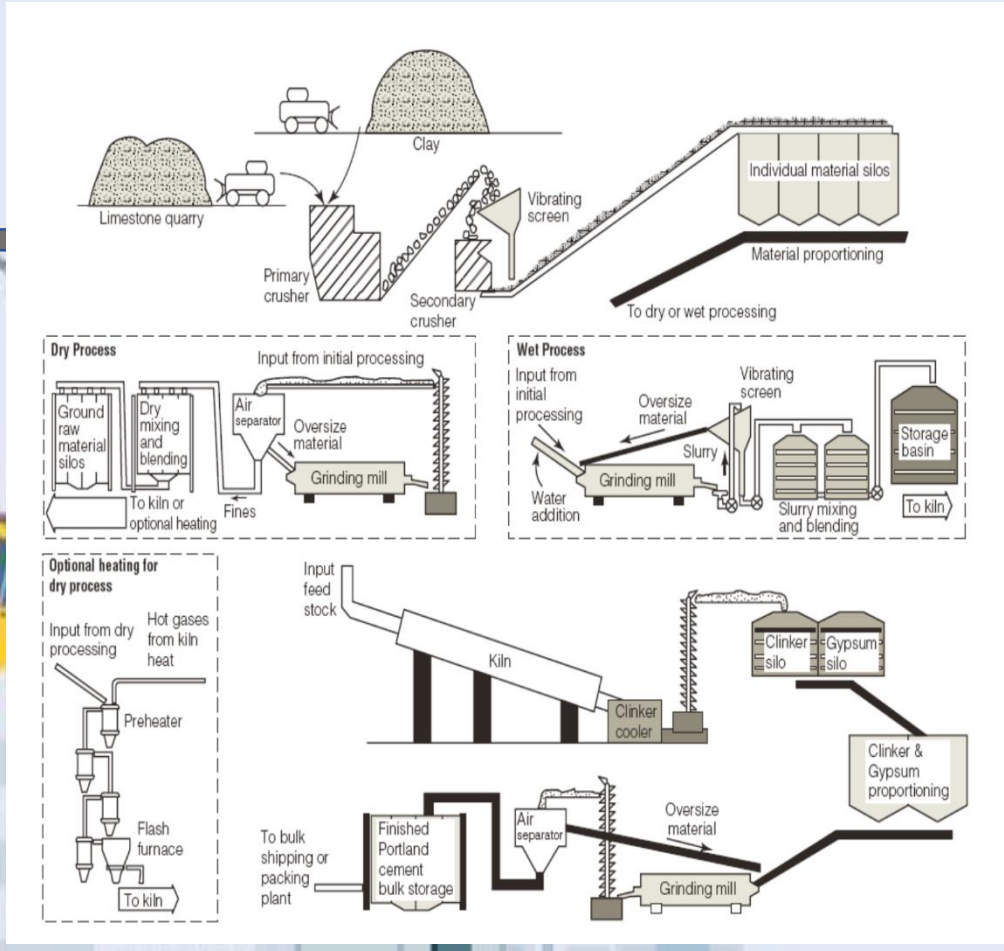
make up the bulk of a concrete mixture. Sand, natural gravel and crushed stone are mainly used for this purpose.

WATER used for mixing concrete should be free from substances such as silt, soil, organic acids and other organic materials such as salt and alkali.

- Usually the water used for mixing concrete is eligible drinking water or taken from approved source.

CEMENT

PC is named after the limestone & chalk cliffs on the Isle of Portland, where it was first made in the early 1800s.



Cement paste = cement + water.
Glue (or binder) that bonds aggregates together to make concrete.
Mortar = cement paste + sand.
Concrete = cement + water + sand + aggregates

8 types of Portland Cement knowingly as:

a) Ordinary Portland Cement @ OPC.
b) Rapid-Hardening Portland Cement @ RHPC.
c) White & Coloured Portland Cement.
d) Low Heat Portland Cement @ LHPC .
e) Portland-Blast furnace Cement.
f) Sulphate Resisting Portland Cement.
g) High Strength Portland Cement.
h) Masonry Cement.

CEMENT

RAPID-HARDENING PORTLAND CEMENT (RHPC)

i. Hardens rather more rapidly than OPC.
ii. It is similar in chemical composition to OPC but proportions of various compounds may be slightly different, and is more finely ground.
iii. Due to it finer grinding, it will increase the rate of hydration at early ages.

ORDINARY PORTLAND CEMENT (OPC)

i. Has a medium rate of hardening & suitable for most type of work.
ii. One of the most commonly used for structural purposes when the special properties specified for other four types of cement are not required.

WHITE & COLOURED PORTLAND CEMENT

i. Used as decorative work.
ii. White cement is made by using china clay in a place of ordinary clay in order to exclude impurities, especially iron oxide & lime stone.
iii. Coloured cement are made by mixing a pigments with Portland Cement.

LOW HEAT PORTLAND CEMENT (LHPC)

i. LHPC hardens & evolves heat more slowly than OPC.
ii. It has slightly different chemical composition.
ii. It obtained by increasing the proportion of Dicalcium Silicate (C2S) & reducing Tricalcium Silicate (C3S) & Tricalcium Aluminate (C3A). It thus hydrates more slowly and evolves heat less rapidly than the OPC.
iii. The development of early strength is less than OPC but ultimate strength is the same. The initial setting time is greater than OPC.
iv. Used for mass concrete applications.

CEMENT

SULPHATE-RESISTING PORTLAND CEMENT

i. Used for resistance extensive exposure sulphates. Typical applications include hydraulics structures exposed to water with high alkali content & structures subjected to seawater exposure.

ii. Has a higher content of Tetra-Calcium Aluminoferrite (C4AF).

iii. The colour is more darker compare to OPC.

MASONRY CEMENT

For hand works uses such as rendering and bricklaying, mortars composed only of Portland Cement & sand are not ideal.

HIGH STRENGTH PORTLAND CEMENT

i. Produced by the same materials as in the case of OPC.

ii. The higher strengths are achieved by increasing the Tricalcium Silicate (C3S) content and also by finer grinding of the clinker.

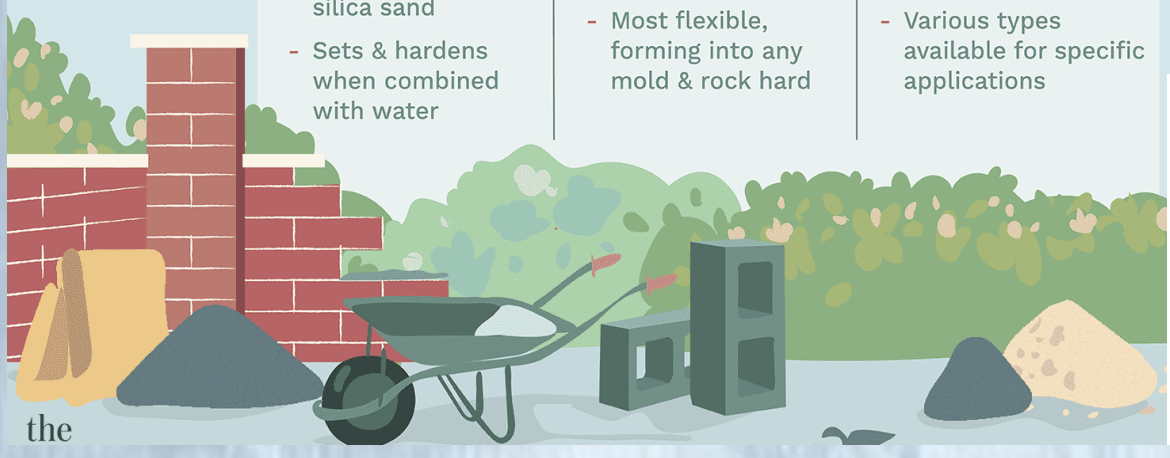
iii. The initial & final setting times are same as OPC.

Cement vs. Concrete vs. Mortar

- Binding element in both concrete & mortar
- Made of limestone, clay, shells, & silica sand
- Sets & hardens when combined with water

- Made of cement, sand, & gravel
- Used for building: foundations, slabs, patios, & masonry
- Most flexible, forming into any mold & rock hard

- Made of cement & sand
- Used as the glue to hold bricks, blocks, etc. together
- Various types available for specific applications



the

CEMENT SILO

STORE STORAGE

1) The arrangement should be such that it is convenient both for stacking and removal of cement bags and it also leaves adequate space for movement and inspection of bags for counting purposes.

2) No cement bags should be stacked in contact with an external wall. A clear space of at least 60 cm should be left between the exterior wall and the stacks.

3) Cement bags should be placed closely together in the stack to reduce circulation of air as much as possible.

4) Cement bags should not be stacked more than ten bags high to avoid lumping or 'warehouse pack' under pressure.

5) If the stack is more than seven bags high, arrange the bags in header and stretcher Fashion.

6) **For extra safety during rainy season**, the stacks of cement bags should be enclosed completely in polythene sheets or similar material.

7) This can be achieved by making a large loose sack of the polythene sheet and arranging cement bags within it with flaps of the sheet closing on the top of the pile.

8) Care should be taken to ensure that the polythene sheet is not damaged any time while in use.

SILOS STORAGE

1) Stored in dry conditions to prevent freezing of the air (air setting) to establish the details of the half-frozen cement.

2) Silo must be in waterproof.

3) **INSPECTION** should be done regularly to detect that it is always air-tight and waterproof.

4) Keeping with this method is better for use with a minimum of labor.

5) Avoid waste if the bag of cement leakage or rupture.

6) Controlled in a working and efficient storage.

7) Silo is a place to store the cement at the concrete mixing plant (batching plant).

AGE OF CEMENT % REDUCTION IN ITS STRENGTH

3 Months 20-30
6 Months 30-40
12 Months 40-5

AGGREGATE

a) **Normal Aggregate** – Rushed Rock, Sand & Gravel, Broken Bricks.
b) **Light Weight Aggregate** – Pumice, Expanded Shale, Expanded Clay.
c) **Heavy Weight Aggregate** – Magnetite, Hematite, Limonite.

- **The functions of aggregate in concrete** is as a mass particle which are suitable for resisting action of applied load, abrasion & percolation of moisture and the action of weather.
- It is also as to reduce the volume changes resulting from setting and hardening of concrete.

Normal Density Aggregate:
Aggregate having a specific gravity between about 2.5 and 3.0 & a bulk density in ranges 1450 to 1750 kg/m3.

It can be classified as normal aggregate and it may be of crushed aggregate or naturally reduced in size.

Light Weight Aggregate:
Any aggregate with a particle density of less than 200 kg/m3 or dry loose bulk density of less than 1200 kg/m3 is defined as Light Weight Aggregate.

HIGH DENSITY AGGREGATE:
Aggregate of specific gravity, that is ranging from 2.8 to 2.0 & unit weight from 2800 to 2900 kg/m3 are used to make high density concrete.

CHARACTERISTICS OF AGGREGATE

1) **The aggregate used in concrete must be clean, hard, strong, properly shaped & well graded.**

2) **The characteristics includes are that, it must possess chemical stability, abrasion resistance, resistance to freeze & thawing, compressive strength, good particle shape & surface texture.**

3) **The Chemical Stability of an aggregate indicates that the aggregate will not react chemically with cement or be affected chemically by other external influences.**

4) **The Abrasion Resistance of an aggregate is often used as a general index of aggregate quality. Abrasion resistance is essential when the aggregate is used in concrete subject to abrasion as in floors & pavements.**

5) **Resistance to freeze & thawing is important when the aggregates are used in exposed concrete. The freeze-thaw resistance of an aggregate is related to its porosity, absorption & pore structure.**

6) **The Compressive Strength of an aggregate is its resistance to compressive forces.**

7) **The Particle Shape & Surface Texture of an aggregate influence of the properties of fresh concrete more than they affect the properties of hardened concrete.**

COARSE AGGREGATE

PHYSICAL PROPERTIES OF AGGREGATE

1) It can be classified into: Strength, Hardness, Toughness, Durability, Porosity & Water Absorption.

Strength

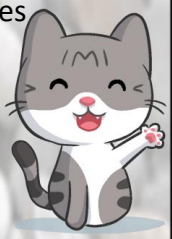
a) The strength of concrete cannot exceed of the bulk of aggregate contained therein.

b) Normally, the strength of concrete does not exceed 80 N/mm2 and generally between 20 – 50 N/mm2.

c) Whilst the strength of rock aggregate (coarse) varies between 70 – 350 N/mm2.

d) A good aggregate value of crushing strength of aggregate is 200 N/mm2.

e) The test conducted to determine the strength of aggregate are namely as **Aggregate Crushing Value, Aggregate Impact Value & Ten Percent Fines Value.**



Toughness

a) The resistance of aggregate to failure by impact.

b) It can be determined by **Aggregate Impact Test.**

Durability

a) Is the ability of aggregate to withstand external or internal damaging attack (soundness of aggregate).

b) This can be obtained by carrying out **Soundness Test.**

c) Aggregate with high modulus of elasticity generally produces a concrete with higher modulus of elasticity.

d) Aggregate with high modulus of elasticity also affect the magnitude of creep & shrinkage of concrete.

Porosity

a) Aggregate normally have pores of various sizes. Some are small & some are big.

b) Aggregate will absorb water when its dry but release water in the concrete mix when its wet.

c) The amount of water and its rate or permeation depends on the size & volume of aggregate.

Hardness

- It is the ability of the aggregate to withstand wear @ load @ applied pressure.
- **The test for obtain the hardness of aggregate is the Abrasion Test.**

Water Absorption

a) Is the weight of water absorbed by an oven dry aggregate in reaching the saturated & surface dry condition.

b) The water absorption is express as percentage of the weight of the dry aggregate (moisture content).

c) Its determine by measuring the increase in weight of an oven dry sample immersed in water for 24 hours & weighed at a saturated and surface dry condition.

CIVIL ENGINEERING MATERIALS

CHAPTER 2.0
CONCRETE WORKS AT THE CONSTRUCTION SITE

CONCRETE WORKS

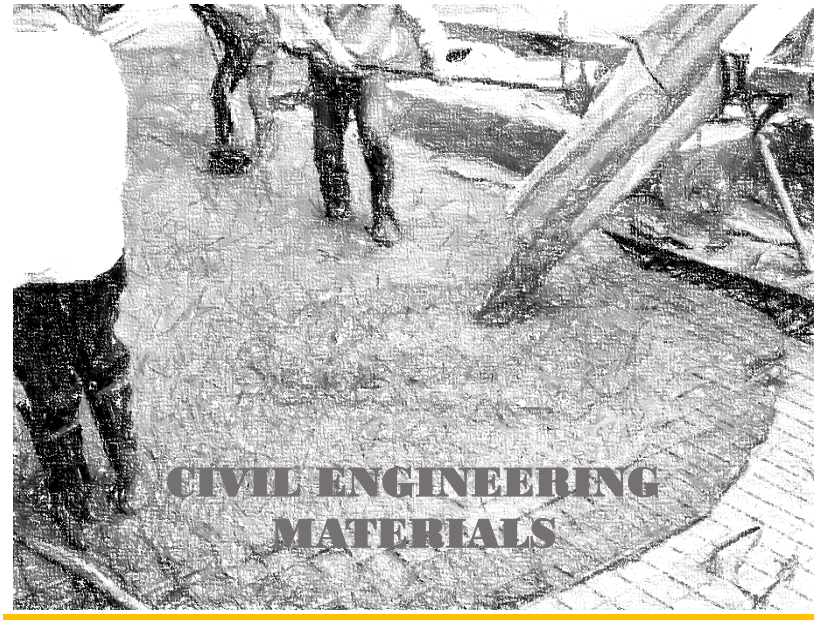
AT THE CONSTRUCTION SITE

Definition:

Concrete work includes the following basic processes of preparation of the concrete mix, delivery of mix to the construction site, feeding, distribution, and compaction of the mix in the formwork the curing of the concrete while it is hardening and quality control of the concrete work.

''Encyclopedia"

CHAPTER 2.0



2.1 Determine the cause and effects of segregation and bleeding on concrete.

Definition of segregation and bleeding.

SEGREGATION

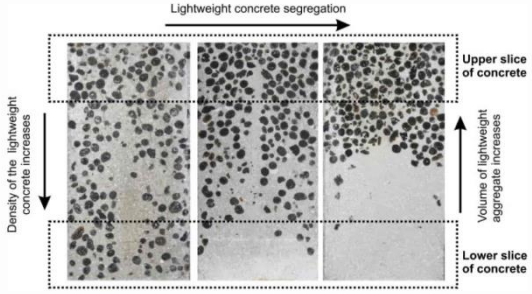
Separation of constituent materials in concrete which is coarse aggregate, sand and cement paste become separated each other.

BLEEDING

Development of a layer of water at the top or surface of freshly placed concrete. The cause of bleeding is the settlement of solid particles

Three (3) Types of Segregation of Concrete

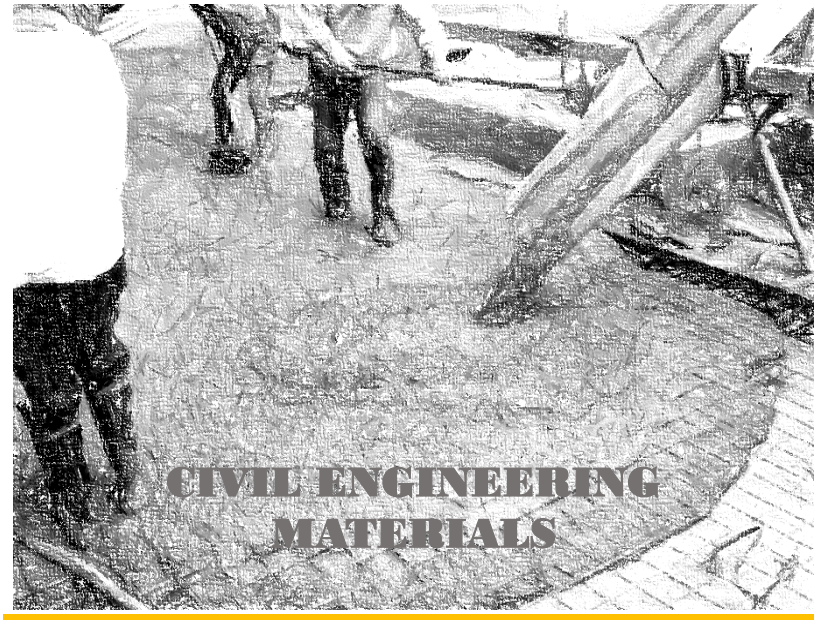
1. Separation of coarse aggregate from the concrete mixture.
2. Separation of cement paste from the concrete during its plastic stage.
3. Separation of water form he concrete mix (Bleeding in concrete)



SEGREGATION OF CONCRETE

Source: Afonso Miguel Solak (research gate)

CHAPTER 2.0



2.1.1 STATE THE FACTORS THAT INFLUENCE SEGREGATION AND BLEEDING CONCRETE MIXTURE

SEGREGATION of concrete will:

i. adversely affect the properties of hardened concrete,

ii. it will significantly reduce the strength and durability

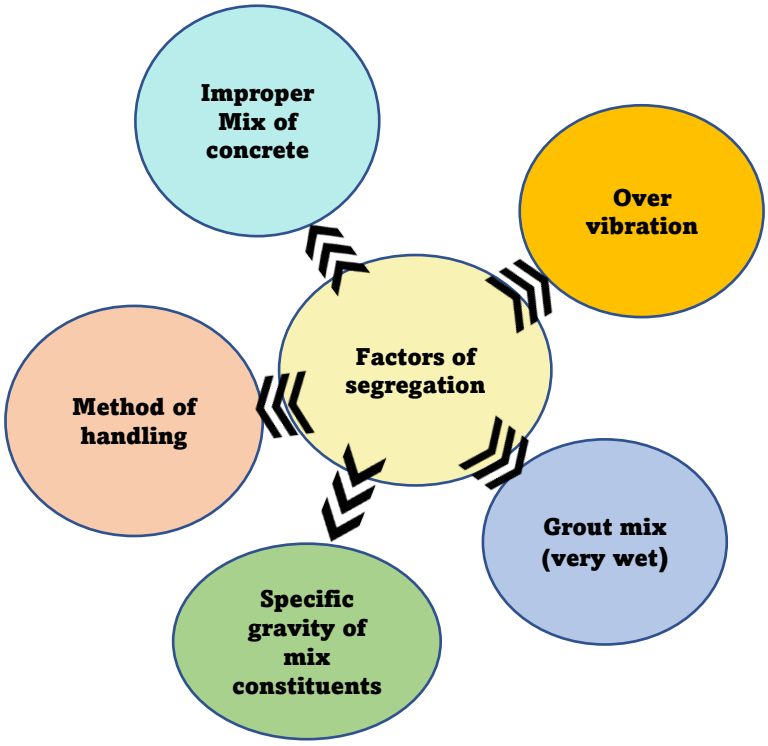
COHESIVENESS

is an important characteristic of concrete, ability of concrete to hold all ingredient together during placing and compacting:

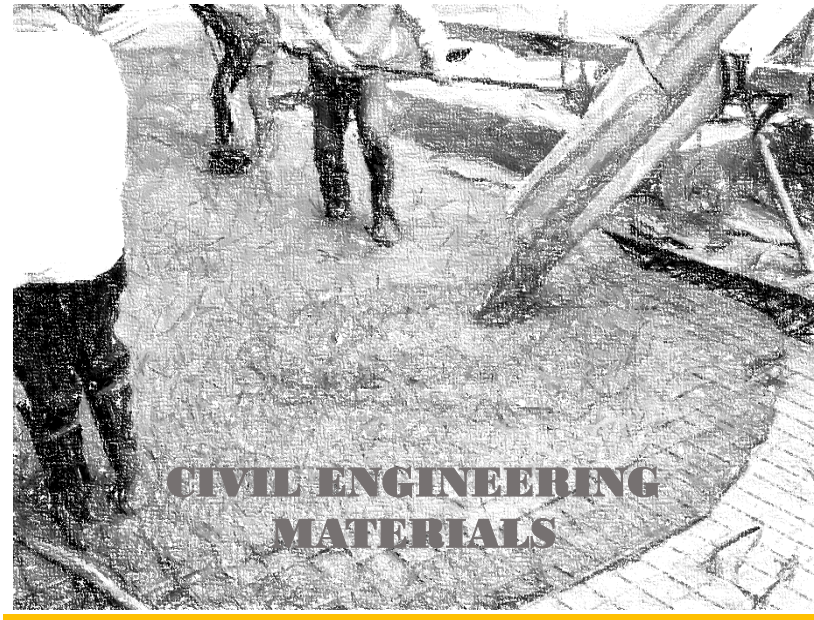
PRECAUTIONS

To Prevent Segregation and Bleeding :-

- Control water cement ratio (not to dry or to wet)
- Place concrete less than 1.5 meter height
- Transportation -Load concrete carefully
- Control time of vibration
- Proper formwork (tight)



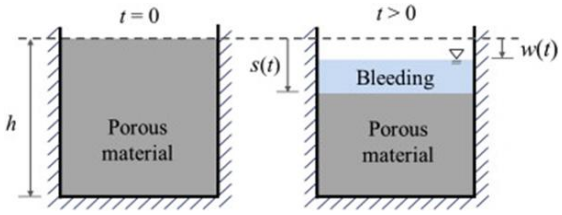
CHAPTER 2.0

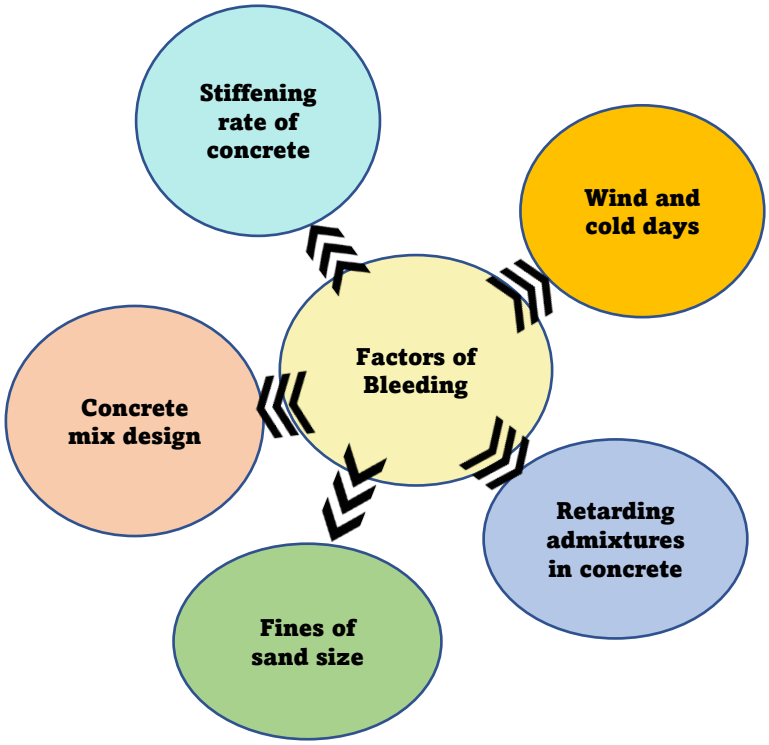


2.1.1 State the factors that influence segregation and bleeding concrete mixture

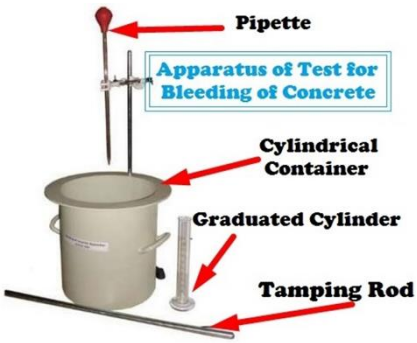
BLEEDING of concrete:

i. Bleeding ordinarily occurs in the wet mix of concrete.,
ii. Bleeding of the water continues till the cement paste has hardened enough





Apparatus Required For Bleeding Test Of Concrete



Source: Er. Mukesh Kumar (ProCivilEngineer.com)

METHODS TO REDUCE BLEEDING IN CONCRETE

- Reduce the water content
- Increase the amount of cement
- Use cementitious materials with finer particles.
- Increase the amount of fines in the sand.
- Use or increase the materials such as fly ash, slag cement, or silica fume.
- Use chemical admixtures or provide other to reducing the bleeding of concrete.
- Use air-entrained concrete.

EFFECT OF SEGREGATION AND BLEEDING ON QUALITY OF CONCRETE

EFFECTS OF SEGREGATION

- Cause of concrete weak in strength
- Concrete not in homogeneous mass throughout the structure
- Will cause of Rock pockets, sand streaks and porous layers in hardened concrete
- mortar comes to the top of the surface, which causes plastic shrinkage cracks.
- concrete will difficult to compact properly

Source: Surkanya,2014 (civilblog.org)

EFFECTS OF BLEEDING

- Concrete will lose its homogeneity.
- Causing permeability in concrete.
- Reduces the bond between the reinforcement and concrete.
- Reduces bond between the aggregate and cement paste.
- Reduced ability of concrete
- Increase in the water-cement ratio at the top.
- Delayed surface finishing.

Source: civilengineeringforum.me (2017)

CHAPTER 2.0

2.2 APPLY THE BASIC CONCEPTS OF CONCRETE WORKS AT THE CONSTRUCTION SITE.

Batching method of concrete

1. Is the selection of a proper mix is based on the kind of work or exposure condition the concrete will subjected to.

2. The design of concrete mix involves the determination of the most economical and practical combination of ingredients to make the concrete workable in its plastic state and to make it develop the required qualities when hardened.

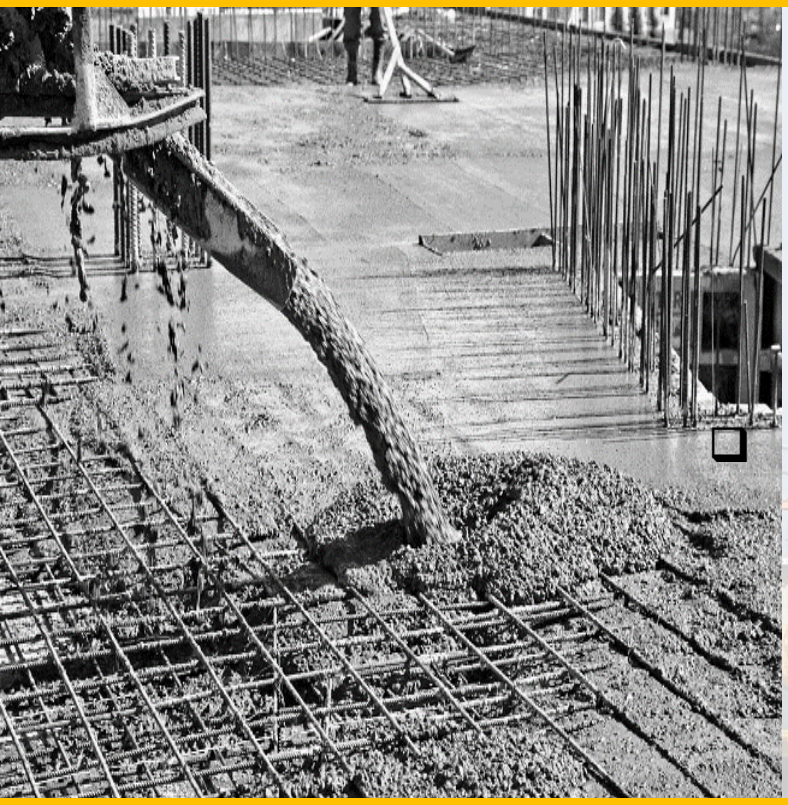
3. The methods of proportioning concrete mixes can either be done by weight or by volume.

4. The choice of proper batching system are:

- Size of job.
- Required production rate.
- Required standards of batching performance.

WEIGHT BATCHING

- It used for most large and important jobs the batching of materials.
- In weight batching, the weight of surface water carried by the wet aggregate must be taken into account.
- Batching by weight eliminates error due to variations in the properties of voids contained in a specific volume, especially with the batching of sand.



- The batching equipment falls into three (3) general categories, namely:
  - Manual Batching – All operations of weighing and batching of concrete ingredients are done manually. Used for small jobs only.
  - Semiautomatic Batching – the aggregate bin gates for charging batchers are opened by manually operated switches. Gates are closed automatically when the designed weight material has been delivered.
  - Automatic Batching – In which all scales for the materials are electrically activated by a single switch and complete autographic records are made of the weight of each material in each batch.
- The batching plant generally comprises of 2, 3, 4 or 6 compartment bins of several capacities together with a supporting system.

VOLUME BATCHING

- For most small jobs, volume batching is adopted, i.e. the amount of each solid ingredients is measured by loose volume using measuring boxes, gauge box, hopper or wheel barrows.
- The accuracy of any method of measurement in which a gauge box or hopper is filled a certain level depends on:
  - Bulking of sand.
  - The closeness with which the material packs.
  - If the material packs closely with few air voids, the solid volume of material is greater than if the material is packed loosely.
- In volume batching, it is generally advisable to set the volumes in term of whole beg of cement.
- Sources of error in volume batching of aggregate are:
  - Variations in the solid volume of aggregate contained in a specified measured volume. It can be minimized although it is difficult to eliminate it.
  - Error in measured volume. This error can reduced by careful attention to the type of measure.

MIXING OF CONCRETE

1. Objective of mixing is to coat the surface of all aggregate particles with the cement paste and blend the ingredients into a uniform mass.

2. Since the natural occurring materials have variables properties, the human factor becomes important.

3. The human should monitor visually the workability, homogeneity and cohesiveness of each mix, as well as the consistency of production.

4. Concrete mixing is usually done by mechanical means called mixer, but sometimes the mixing of concrete is done by hand.

5. Machine mixing is more efficient and economical compared to hand mixing.

MACHINE MIXING

- It can either be in rotation or stirring operation.
- The rotation operation is used in tilting drum mixer, non-tilting drum mixture, dual drum mixer and continuous mixer, while the stirring operation is used in a pan type mixer.
- Tilting Drum Mixer:
  - A tilting drum mixer is one whose drum in which mixing take place is tilted for discharging.
  - The drum is conical or bowl shaped with internal vanes, and the discharge is rapid and unsegregated so that these mixers are suitable for mixes of low workability and for those containing large size aggregate.
- Non-Tilting Drum Mixer:
  - A non tilting drum is one in which the axis of the mixer is always horizontal and discharge take place by inserting a chute into the drum or by reversing the direction

or rotation of drum.

  - Because of slow rate of discharge, some segregation may occur.
- Dual Drum Mixer:
  - A dual drum is sometimes used in highway construction.
  - Here there are two drums in series, concrete being mixed part of the time in one and then transferred to the other for the remainder of the mixing time before discharging.
- Continuous Mixer:
  - These are fed automatically by a continuous weigh-batching system.

HAND MIXING

1. There are many occasions when the concrete has to be mixed with hand, and because of this case uniformity is more difficult to achieve, therefore particular care and effort are necessary.

2. The aggregate should be separated in a uniform layer on a hard, clean and non-porous base.

3. Cement is then should be spread over the aggregate and the dry material are mixed turning over from one end of the heap to another and cutting with a shovel until the mix appear uniform.

4. The water is gradually added to trough formed by the uniform dry mix and the mix is turned over until a homogeneous mixture of uniform colour and consistency is obtained.

TRANSPORTING OF CONCRETE

Method of transporting concrete

1. The method used to transport concrete depends on which one is the lowest cost and easiest for the job size.

2. On small jobs, a wheelbarrow is the easiest way to transport concrete.

2.1.1 Define; segregation and

3. However, concrete can be handled and transported by many methods, including use of chutes, a concrete truck, a concrete pump and a crane.

4. The main consideration is selecting the type of equipment to be used is an economic one, however, certain jobs require specialized equipment and thus the cost is a secondary consideration.

5. The other considerations are; the segregation of aggregate, loss of entrained air, loss of cement paste, change in slump and accumulation of harmful materials.

CHUTE

- Chute used to transport concrete from top to bottom without a part separation.
- It made from PVC pipes or sometimes made of wood and metal.
- The length of chute is limited to only 3m long.
- It diameter approximately 300mm.

CONCRETE PUMP

- The use of pumps is one method that is quick, clean and economical, if carefully planned.
- Using the pipes 6” which is pumped from the concrete mix. Used for a large quantity of concrete.
- Can carry as far as 30m to 50m vertically and 300m to 500m horizontal direction.
- Consists of two types either in plunger pump or squeeze pump.
- The concrete pump is usually used if there is problems like this:
  - The location of construction sites in urban areas is crowded, difficult to use the truck and transportation equipment.
  - Limited road facilities.
  - Construction site near the existing building, difficulty entering the area or the storage problem of raw materials.
  - The site location is not suitable for heavy machinery.
  - Lack of labor. The use of machinery tends for maximized productivity.
  - The contingency of project and need of permanent construction.
  - The construction of structures that is too high.

CRANE

- There are two types of crane namely as Tower Crane Bucket and Mobile Crane Bucket.

- Mobile Crane Bucket – Used for large projects and the construction of structures that are very high. Where concrete is included in a large container equipped with a trap door in the bottom and covered directly through the skip.

- Tower Crane Bucket – Tower cranes used for building higher than 30 meters. Mobile cranes are only limited to buildings with a height of 20 meters. Using skip depends on the size of the load. Skip size is limited to a maximum size of 0:57m³ or 1394kg.

READY MIX CONCRETE

- If instead of being batched and mixed on site, concrete is delivered for placing from a central plant. It is referred to as ready-mixed or pre-mixed concrete.
- This type of concrete is used extensively abroad as it offers numerous advantages in comparison with other methods of manufacture:
  - Close quality control of batching which reduces the variability of the desired properties of hardened concrete.
  - Use on congested sites or in highway construction where there is little space for a mixing plant and aggregate stockpiles;
  - Use of agitator trucks to ensure care in transportation, thus prevention segregation and maintaining workability
  - Convenience when small quantities of concrete or intermittent placing is required.
- There are two categories of ready-mixed concrete: central-mixed and transit mixed or truck mixed.
- In the first category, mixing is done in a central plant and then concrete is transported in an agitator truck.
- In the second category, the materials are batched at a central plant but are mixed in a truck.

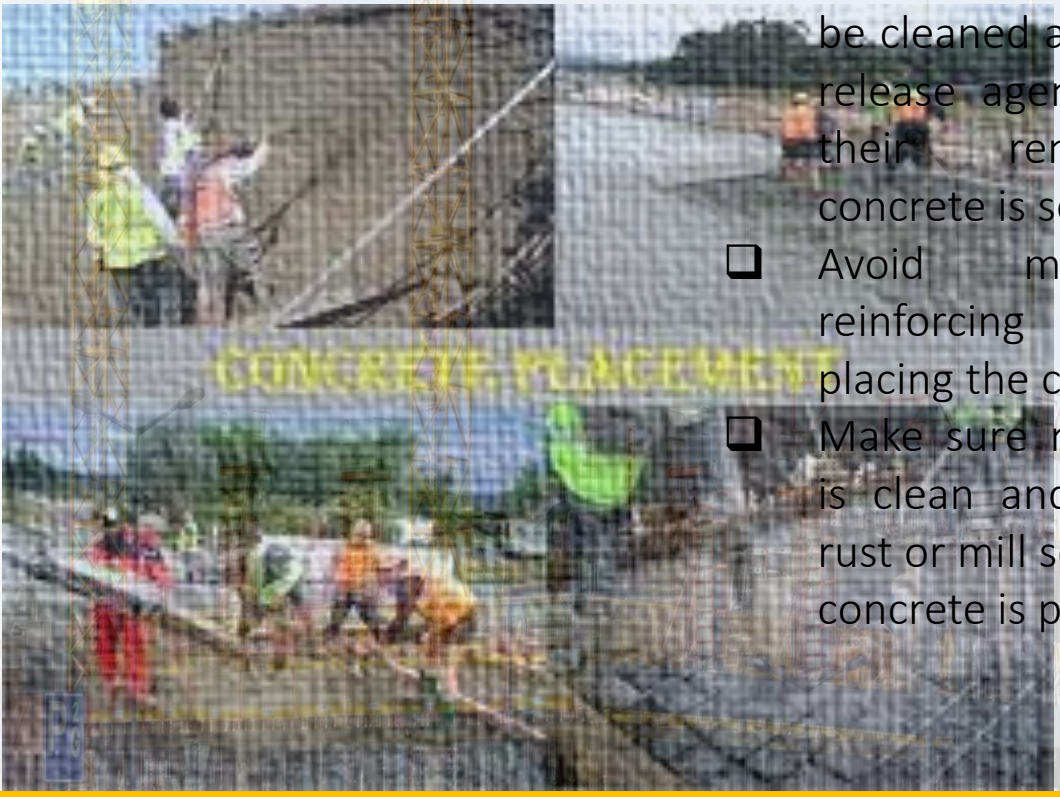
PLACING OF CONCRETE

To secure a good concrete, it is necessary to make certain proportions, such as:

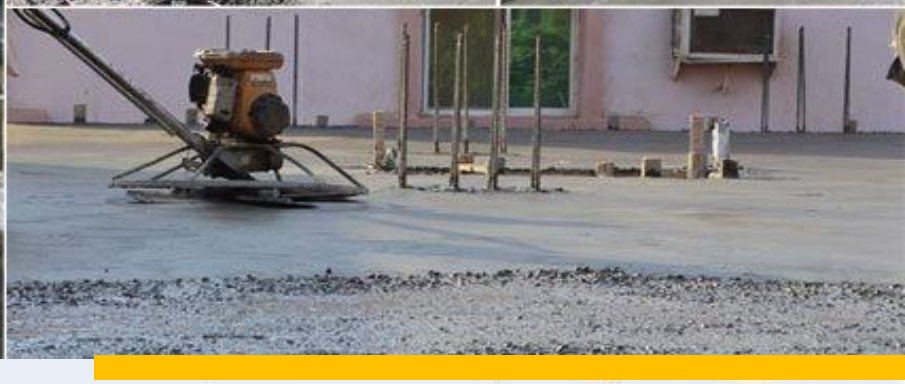
- The ready mixed concrete must be placed as near to its final position as possible, so that it is not too stiff to work.
- When placing concrete, be careful not to damage or move formwork & reinforcement.
- Start placing from the corners of the formwork or, in the case of a sloping site, from the lowest level.
- Water should not be added after the concrete has left the mixer.

Cont’

- When placing concrete, care should be taken to drop the concrete vertically and not great at height. Never allow the concrete to fall more than 1 to 1.5 meters.
- The forms must be examined for correct alignment and adequate rigidity to withstand weight of concrete.
- The forms must be checked for tightness to avoid any loss of mortar which may result in honeycombing.
- Wood form should be moistened before the concrete is placed, otherwise it will absorb water from concrete and swell.
- In addition, the forms should be oiled or lacquered to make form removal easier.
- The inside of the form must be cleaned and treated with release agent to facilitate their removal when concrete is set.
- Avoid movement of reinforcing steel when placing the concrete.
- Make sure reinforcing steel is clean and free of loose rust or mill scale at the time concrete is placed.



COMPACTING OF CONCRETE



1. **WHAT IS COMPACTION:** Compaction is done by shaking, or vibrating, the concrete which liquefies it, allowing the trapped air to rise out. The concrete settles, filling all the space in the forms.

2. **WHEN TO COMPACT:** Compaction must be done as concrete is placed, while it is still plastic. Never let concrete dry-out and stiffen because it will be too hard to compact.

3. **WHY COMPACT:** Properly compacted concrete is more dense, strong and durable. Off-form finishes will also be better.

4. Method of compaction can either be hand compaction or machine compaction:
   - ❑ Hand Rodding.
   - ❑ Machine Compaction. Examples are: Internal Vibrator – Pocker, External Vibrator – Clamped to Formwork and Platform.

HAND COMPACTION

- Hand compaction methods consists of rodding, tamping and spading with suitable tools.
- Concrete mix that normally use for hand compaction are of fairly workable mix if the sections are **at narrow and the reinforcement closely packed**.

MACHINE COMPACTION

EXTERNAL VIBRATOR:

SCREEDING:

- Screeding levels and compacts thin concrete slabs and the top layers of thicker slabs.
- A screed board will not compact the concrete very well.
- Mechanical vibration or hand rodding is required to provide adequate compaction.

THE MECHANICAL SCREED:

- Concrete is screeded TWICE.
- The first screed levels the concrete roughly and compacts it.
- The second screed levels and compacts the concrete more.
- The screed is pulled along the top of the forms by two workers.
- Always keep a small amount, or surcharge, of concrete, in front of both beams of the screed to avoid holes forming in the surface.
- If a hollow develops, the screed will not compact the concrete. The mechanical screed compacts the concrete as it vibrates.

Cont’

INTERNAL VIBRATOR:

Internal vibration is done with a mechanical vibrator or poker vibrator. The POKER is put into concrete and vibrates it from the inside.

I)METHODS:

- Make sure there are enough workers so some can compact while others continue to place.
- Put the poker into the concrete QUICKLY.
- Take the poker out very SLOWLY otherwise a hole, or weak spot, may be left in the concrete.

- The SIZE of the poker determines how much concrete is vibrated at one time.
- The area vibrated at one time is called the RADIUS OF ACTION.
- This can be seen by over what radius air bubbles rise to the surface.
- The radius of action will be greater with a LARGER poker and more-workable concrete.
- Always compact in a definite pattern so the radius of action overlaps and covers the whole area of the concrete.
- The poker should be long enough to reach and enter into the layers of concrete under the one being compacted.

Cont’

II) PRECAUTIONS:

- Taking the poker out TOO QUICKLY will leave a hole in the concrete.
- To close the hole, vibrate near the hole and take the poker out VERY SLOWLY.
- NEVER touch the form face with the poker as it can damage the formwork and the concrete.
- NEVER touch the reinforcement with the poker.
- NEVER spread or move concrete sideways with the poker, always use a shovel.
- NEVER leave the poker running when not in use

III) HOW LONG TO COMPACT:

- For concrete of average workability (ie slump of 80 mm) with a poker size between 25–75 mm, concrete should usually be vibrated for between 5 and 15 seconds.
- It is worse to UNDER-VIBRATE than to OVER-VIBRATE concrete.

CURING OF CONCRETE

1. WHAT IS CURING:

- Curing means to cover the concrete so it stays MOIST.
- By keeping concrete moist the bond between the paste and the aggregates gets stronger.
- Concrete doesn't harden properly if it is left to dry out.

2. WHEN TO CURE:

- Curing is done just after finishing the concrete surface, as soon as it will not be damaged.
- When curing, leave the formwork in place to help reduce water loss. In hot weather (above 30°C), or during high winds and low humidity, concrete can dry out easily.
- In these conditions take extra care while curing.

3. WHY CURE:

i. Concrete that is cured are LESS LIKELY TO CRACK, More DURABLE and STRONGER.

ii. Cured concrete has a surface that wears better, lasts longer and better protects the steel reinforcement. The concrete can carry more weight without breaking.

Cont’

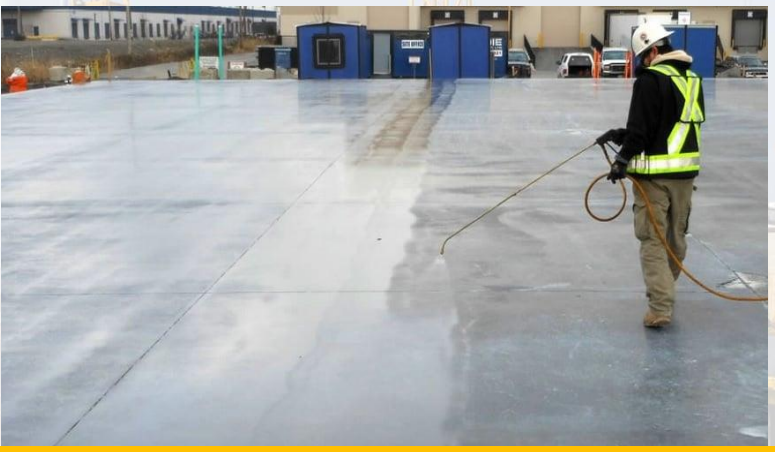
4. HOW TO CURE:

❑ WATER CURING:

- Curing by flooding, ponding or mist spraying is widely used.
- It is the most effective curing method for the prevention of mix water evaporation.
- This method is not always practical, however because of job conditions.
- Continuous sprinkling with water is also excellent method of curing.

❑ COVER WITH PLASTIC SHEET:

- Another way to cure concrete is to cover with PLASTIC SHEETS to slow down water loss.
- This method is easy and cheap.



- The only problem is that the sheets may cause concrete to become darker in places.
- To avoid this keep concrete EVENLY moist.
- The sheets must be held down to stop them blowing away and the concrete surface drying out.
- The sheets can be overlapped and stuck together and/or held down with sand, timber or bricks.
- Always check under the plastic from time to time to make sure the concrete is EVENLY moist.
- If it feels dry, sprinkle with water and put back the plastic sheets carefully.
- Condensation on the underside of the plastic is a good sign.

Cont’

❑ CHEMICAL MEMBRANES :

- Chemical can be sprayed on the surface to cure concrete.
- Liquid membrane-forming curing compounds retard or prevent the evaporation of moisture from the concrete.
- The chemical application should be made as soon as the concrete is finished.
- If there is any delay in the application, the concrete must be kept moist until the membrane is applied.
- The membrane curing compound must not be applied when there is free water on the surface or after the concrete is dry.
- Sodium silicate solution is one of the chemical curing.

❑ STEAM CURING:

- In steam curing, the heating of the concrete products is caused by steam either at low or high pressure.
- The method ensures even heating of products all over, even if the space between the stacked precast concrete products is very small.
- Steam curing is more favorable to mix of concrete with low water cement ratio than mixes with higher water-cement ratio.

Cont’

5. HOW LONG TO CURE

- Concrete keeps getting HARDER AND STRONGER over TIME.
- Household concrete jobs MUST be cured for at least 3 DAYS.
- For better strength and durability, cure concrete for 7 DAYS.
- The LONGER concrete is cured, the closer it will be to its best possible strength and durability.

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Terbitan:

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